



LAI Initiatives and Research on SYSTEMS ENGINEERING

3rd Quarter Progress Report

Donna Rhodes, rhodes@mit.edu

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Highlights

The LAI research group at MIT has made significant progress during 3rd quarter 2004 in the systems engineering knowledge area, including:

1. Synthesis and distribution of the results of the June 2004 **AF/LAI Workshop on Systems Engineering for Robustness** to attendees, LAI membership, and larger systems community.
2. Launching several of the action teams to address specific initiatives as follow-on to the June workshop, completing one deliverable and a progress report on Leading Indicators.
3. Enhancing the systems engineering research agenda and initiating new research efforts in systems engineering.
4. Continuing to foster a dialogue on systems engineering revitalization and engineering for robustness within the aerospace community as well as the larger systems community.

LAI Systems Engineering Knowledge Area Advisors, Staff, and Students

- Reports for LAI initiatives cite additional individual contributors from systems engineering community

Researchers:	
LAI at MIT, Lead for SE Research	Dr. Donna Rhodes
LAI at MIT, Lead for PD Research	Dr. Eric Rebentisch
MIT Faculty Advisor for SE Research	Professor Daniel Hastings
LAI Executive Advisors for SE	Mrs. Marty Evans, US Air Force Dr. Michael Winter, Pratt & Whitney
LAI Funded/Affiliated Students working on SE Research	Heidi Davidz, Adam Ross, Ryan Boas, Jason Bartolomei, Matt Richards, Nicole Jordon
Visiting Researcher	Dietrich Falkenthal, MITRE Corporation

SYNTHESIS/DISTRIBUTION OF WORKSHOP RESULTS

The June **AF/LAI Workshop on Systems Engineering for Robustness** brought together over 80 leading systems engineering professionals for a 2 day event. Very positive feedback was provided by the participants who expressed the value of having a dialogue on the evolution of systems engineering and setting directions for future efforts. One attendee remarked, *"There is no doubt there is much more work to be done and I'm confident the results of the entire workshop will go a long way to supporting Dr. Sambur's goals with respect to SE and robustness"*.

Impact of the workshop has extended beyond the direct participants who were provided direct distribution of the briefings and workshop report as email attachments. Beyond this distribution, the workshop briefing package has been downloaded from the LAI website **339 times** and the workshop report has been downloaded **437 times** as of mid-October. This interest in LAI reports has been accelerated by the activities and events cited in the section below regarding fostering a dialogue.

LAI INITIATIVES ON SYSTEMS ENGINEERING.

The workshop outlined six specific initiatives to be worked during the second half of 2004, with continuing activity in 2005. Action teams have been (or are under formation) for each initiative with co-leadership and membership comprised of respected systems engineering practitioners with significant experience in the area of the focus. The following outcomes have been accomplished:

Publication of Technical Report on Value of Systems Engineering. This report provides a comprehensive summary of seven studies that have been done to date related to quantification of the value of systems engineering. The report makes specific recommendations for a comprehensive funded government study that would produce detailed quantified information on the value of systems engineering activities at a level that could be used for planning and decision making.

Next steps: If there is interest in a comprehensive study, a detailed proposal would need to be developed and the study would need to be funded. Two excellent candidates for further development and conduct of such a study are available to work this effort, perhaps assisted by a university or consortium for data collection and tracking. As noted in the report, ad hoc efforts to gather data do not result in the level of and quality of information needed to truly quantify systems engineering value for actionable purposes.

Publication of Progress Report on SE Leading Indicators. This report summarizes the efforts of an action team that is working on the leading indicators initiative. The report summarizes and compiles results of an August workshop held by the team and includes recommendations for the ongoing effort. The team believes there is a need for some new leading indicators, as well as a need to transform measures now used as lagging or progress indicators for use as leading indicators. The report includes some concept level candidates for leading indicators.

Next steps: The action team is continuing its efforts from the August workshop. A technical report will be issued before the end of the year.

Criteria for Good Systems Engineering. A leadership team has been formed to evolve the preliminary work done at the June workshop and also draw on previous work by LAI. Preliminary discussions have been held and work will continue for rest of 2004.

Next step: Continue effort and recruit additional team members as contributors and reviewers. Longer term plan will be to take these results, along with the leading indicators and previous research results, and develop a self-assessment tool for assessing the goodness of systems engineering on a program.

Spiral Capable Process Guidelines. Subsequent to the workshop, a participant from The Aerospace Corporation stepped forward to work this initiative. The means to undertake this effort has been in discussion, and this has now just evolved into a funded project within that organization. However, the efforts are now directed as a deliverable for a specific customer set which may result in issues around proprietary data and it is unknown at this point if the resulting process guidelines can be shared with the LAI Consortium. This has also changed the schedule.

LAI will leverage an upcoming MIT/MITRE Research Collaboration Workshop to make continued progress in this area. The workshop to be held November 19th will include a breakout group for purposes of advancing this area of focus. The workshop may result in concepts and information to directly support this initiative.

Next steps: Consider alternate strategies for developing these guidelines including leveraging past LAI work and current student research. Continue to monitor the efforts of The Aerospace Corporation for availability to LAI consortium. Determine if there is an opportunity to collaborate further with MITRE Corporation after the MIT/MITRE workshop on November 19th.

Considerations for Architecting Robust Systems. A plan is under development to have a mini-workshop on this topic to produce a working paper to capture emerging thoughts and guidance on topic. A number of interested team members have been contacted and will participate, as available. Longer term research is also underway on this topic within the MIT research group on SE, as well as at other leading universities.

Next steps: The mini-workshop will be held before the end of the year, and a working paper developed. The MIT/MITRE workshop will feature a breakout group on architecting, and results from this November 19 event will supplement the initial work in the AF/LAI workshop held in June. This information will provide background information for the planned mini-workshop.

Considerations for System-of-Systems/Enterprise Concept Development. As systems become increasingly complex, along with the extended enterprises needed to develop and sustain such systems, there is an need to evolve system practices. There are many emerging ideas on these topics, however these have not been fully explored and validated, nor have they been brought together in a coherent set of guidance. MIT and other leading university researchers are working on many research projects related to this theme. Subsequent to the June AF/LAI workshop, a specific effort has been initiated to develop foundational information to be available within several months. This effort is a small study that has been initiated with the support of a researcher from MITRE Corporation to gather and synthesize emerging concepts and thinking on this subject.

Next steps: Continue the study and hold a meeting to review results and provide feedback. Publish a working paper on this topic.

LAI SYSTEMS ENGINEERING RESEARCH PROGRAM.

LAI has been performing research on systems engineering for a number of years, and a compendium¹ of this research has been developed and distributed. The LAI research group at MIT has formed an SE Student Research Group, led by Professor Daniel Hastings and LAI SE research leader Donna Rhodes. The group is comprised of faculty, researchers, and six graduate students (four of the students are new in Fall 2004) who are researching SE related topics. The group meets bi-weekly to discuss the evolving research agenda, and students present their work in progress to gain feedback as well as foster collaborative thinking. The group will produce an end of semester summary of work to date.

The LAI research group is also linked to systems engineering research efforts of the International Council on Systems Engineering (INCOSE). Professor Hastings is Chair of the

¹ Lean Aerospace Initiative (LAI), *MIT Research Studies Applicable to Systems Engineering*, June 2004

INCOSE Academic Council looking at policy issues related to systems engineering education. LAI researcher Donna Rhodes is INCOSE Director for Strategic Planning, and is involved in the development of a vision for evolving systems engineering and setting research directions. This involvement enables LAI to engage systems engineering experts from many organizations in LAI initiatives; to ensure research directions of importance to LAI members are part of the larger research agenda; and to leverage the products and resources of the systems community in our specific systems engineering initiatives. Donna Rhodes is also leading a pilot program for a doctoral student research network with four universities which is funded by INCOSE. The network connects student researchers in systems engineering and gives students access to INCOSE Fellows as mentors. Two of the LAI SE research students are participating in this network during 2004, with a goal of exploring synergy of LAI research at MIT with that of other universities. A special track dedicated to the INCOSE student research network at the 2005 *Conference on SE Research (CSER)* will publish interim results of the student's research.

FOSTERING A DIALOGUE

An important aspect of LAI's systems engineering knowledge area includes continuing to foster a dialogue on revitalization, engineering for robustness, and related topics. This dialogue must occur within LAI and the US aerospace community, but also across the larger systems community, with the intention of gaining insight into successful practices in other domains and international organizations. During 3rd quarter, LAI has participated and played a leadership role in a number of events, including:

- International Council on Systems Engineering, Lean Systems Engineering Panel with members of LAI SE EdNet Group
- SAF/AQ Conference on Advancing Systems Engineering, LAI SE initiatives presented as part of Systems Engineering Experts Panel
- AIAA Space 2004 Conference, LAI SE initiatives highlighted as part of panel presentation by on Systems Engineering
- ICSE/INCOSE Regional Symposium, keynote presentation highlighted LAI efforts and two papers by LAI PhD students
- AFIT Visit, Discussions on MIT LAI research group collaboration with AFIT SE faculty to mentor student thesis projects

Selected upcoming events in 4th quarter include:

- MIT/MITRE Research Workshop: LAI research will be presented; breakout group on topics related to systems engineering will be conducted
- MIT/Thales Meeting on Systems Engineering: A meeting with Thales Corporation to exchange information on systems engineering, needs, practices and research directions
- MIT/BMW Meeting on Systems Engineering: A dialogue on systems engineering and robustness with BMW executives, LAI researchers, MIT faculty, and student researchers
- SE EdNet Meeting: Faculty from leading systems engineering programs will meet on topics related to education and research

SUMMARY

Our systems engineering knowledge area has had significant activity in 3rd quarter and the quarter ahead has an aggressive work plan. The primary issue we face is related to the limited availability of systems engineering experts who are willing collaborators, but can contribute only within the limits of their personal availability. LAI is becoming more recognized as a contributor in the systems engineering community. Additional work remains to create effective partnerships with sister consortiums such as Software Productivity Consortium, organizations such as NDIA and INCOSE, and other leading universities with systems engineering research programs.